

The data presented in this Chapter were taken from the Health Promotion and Disease Prevention Supplement to the 1985 NHIS and the Cancer Control Supplement to the 1987 NHIS.

#### National Health and Nutrition Examination Survey and Hispanic Health and Nutrition Examination Survey

Since 1960, the National Center for Health Statistics has conducted periodic health surveys that have included physical examinations and laboratory tests. Initially called the National Health Examination Survey (NHES), the name of this survey was changed to the National Health and Nutrition Examination Survey (NHANES) in 1970 when a nutrition component was added. The NHES was conducted in 1960, 1963, and 1966, and the NHANES in 1971, 1976, and 1988.

Although the NHANES as a population survey included all of the Nation's major subpopulations including Hispanics, the sample sizes were insufficient to produce reliable estimates of health status, particularly if the three major Hispanic subgroups—Mexican-Americans, Cuban-Americans, and Puerto Ricans—were considered separately. Therefore, the Hispanic Health and Nutrition Examination Survey (HHANES) was developed by the National Center for Health Statistics. The HHANES was designed to provide sufficient samples of each Hispanic subgroup. The survey not only produces reliable estimates of health status for each subgroup but also permits cross-cultural comparisons within the broader Hispanic cultural context.

The HHANES was a probability-based survey of three distinct subgroups of a major U.S. minority group rather than of a national sample. The sampling methodology used complex, multistaged, stratified, clustered samples of the defined population. When weighted, the sample data represent the targeted population. For HHANES, the targeted population consisted of three groups of civilian, noninstitutionalized persons, aged 6 months to 74 years from three areas of the country that had a sufficient number or proportion of Hispanics to render it economically feasible to screen households and to operate an examination center: (1) Mexican-Americans residing in selected areas of Texas, California, Colorado, New Mexico, and Arizona; (2) Cuban-Americans residing in Dade County, Florida; and (3) Puerto Ricans residing in the New York City area. Data were collected from 1982 through 1984 via in-person household interviews and via examination at a local examination center. Information was collected regarding a number of health issues, including the use of tobacco.

#### NIDA High School Seniors Surveys on Drug Use

Each year since 1975, the Monitoring the Future project has conducted surveys of representative national samples of high school seniors in the United States (Johnston, O'Malley, Bachman 1987). Monitoring the Future is conducted by the University of Michigan Institute for Social Research and receives its core funding from the National Institute on Drug Abuse.

Each year, a multistage sampling procedure is used to identify approximately 135 public and private schools (the number of private schools has varied from 14 to 22) that

represent an accurate cross-section of high school seniors throughout the coterminous United States. The first stage involves the use of 74 primary sampling units developed by the University of Michigan Survey Research Center for use in its nationwide interview surveys.

The second sampling stage involves choice of a single high school from most geographic areas (more than one is chosen in major metropolitan areas). The probability of selection of any school is proportional to the size of the senior class. When a sampled school is unwilling to participate, a replacement school is selected from the same geographic area. Response rate of schools has been from 66 to 80 percent throughout the survey period.

Up to 400 seniors are surveyed from each school. In schools with more than 400 seniors, a random sampling system convenient for the school (provided it results in an unbiased sample) is used to choose the 400 students to be interviewed. Most schools use the classroom as the basis for this selection. The total number of students interviewed each year has been between 15,700 and 19,000. The student response rate has varied from 77 percent to 84 percent throughout the survey period.

The questionnaire administration in each school is carried out by local Survey Research Center representatives and their assistants following standardized procedures detailed in a project manual. Questionnaires are generally delivered in classrooms during normal class periods, although in some instances larger groups are used. Because of the range of topics, five different questionnaire forms are used in the survey. These are distributed to participants in an ordered sequence to produce identical subsamples. All five forms contain core data on demographics and some drug use (about one-third of the form); all other questions are asked of subsamples of the total respondents. Basic questions on cigarette usage have been included in the core for all years.

Followup surveys by mail are conducted annually using representative subsamples from each of the previously participating classes, that is, the classes of 1976 through 1987. Thus, long-term panel data are collected on individuals, and analyses aimed at separating secular, age, and cohort effects are possible. (See O'Malley, Bachman, Johnston 1988.)

#### NIDA National Household Surveys on Drug Abuse

NIDA conducted household surveys on drug use in 1979, 1982, and 1985. Data were obtained from a stratified random sample of 8,000 U.S. households; approximately 2,000 in-person interviews were conducted with respondents in the 12- to 17-year-old age group. Questions included whether any cigarettes were smoked within 30 days as well as within the previous year.

#### Roper Survey, 1978

This survey was conducted for the Tobacco Institute via face-to-face interviewing with 2,511 subjects. Other methodological details are unavailable.

## Roper Survey, 1980

The 1980 Roper Survey used face-to-face interviews to test a nationally representative sample of 2,000 adults for knowledge about the health hazards of smoking. The study was commissioned by the FTC and was conducted in November 1980. The total sample was split into two halves, and one set of questions was varied between the two. Thus, the sample size for several of the questions on the health effects of smoking was approximately half the total sample size.

## US DHEW Teenage Smoking Surveys

In 1968, 1970, 1972, 1974, and 1979, random samples of teenagers aged 12 to 18 years were surveyed by telephone in December–January (US DHEW 1972, 1976b, 1979b). The first stage of the 3-stage sampling plan involved grouping and selecting telephone exchanges and was designed to eliminate geographic bias. Within the selected exchanges, equal numbers of random-digit-dialed telephone numbers were generated and contacted. Household enumeration was undertaken with an adult respondent and if more than one person aged between 12 and 18 years lived in the house, random selection was used to choose the study participant.

In 1968, the sample size was 4,931, 89 percent of whom were interviewed by telephone. The other 11 percent lived in nontelephone households and were interviewed in their homes. As exclusion of the nontelephone households did not substantially affect prevalence estimates, later surveys did not include household interviewing of nontelephone households. The sample size in 1970 was 2,640; in 1972, it was 2,790; in 1974, it was 2,553; and in 1979, it was 2,639. In 1979, a followup survey was also undertaken of 1,194 (46.8 percent) of the 1974 respondents. Approximately 12,000 households were contacted in 1979, from which 2,639 people aged 12 to 18 years were interviewed. In no survey was there any attempt to validate the smoking status indicated.

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## **CHAPTER 5**

### **CHANGES IN SMOKING BEHAVIOR AND KNOWLEDGE ABOUT DETERMINANTS**

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## **INTRODUCTION**

This Chapter reviews two major aspects of smoking behavior since release of the first Surgeon General's Report on smoking and health in 1964: (1) changes in smoking behavior in the United States (Part I) and (2) changes in our knowledge about the determinants of smoking during this period (Part II).

During the past 25 years, the prevalence of cigarette smoking has declined in virtually every major sociodemographic group, including men and women, adults and adolescents, blacks and whites, and persons with and without college education. This decline has been particularly evident among men, in whom the prevalence of smoking declined from 50 percent in 1965 to 32 percent in 1987. The first part of this Chapter analyzes trends in smoking prevalence, cessation, and initiation, and examines smoking patterns among different sociodemographic groups and other special populations. These analyses are based, for the most part, on cross-sectional population-based data collected periodically since 1964.

At the same time, our knowledge about determinants of smoking has increased substantially. Physiological, behavioral, and social factors that may influence the initiation and maintenance of smoking have been extensively researched. Many important predictors of initiation, quitting, and relapse have been identified. The development of this body of knowledge is reviewed in the second part of this Chapter. Information reviewed in that part of the Chapter is primarily derived from research studies and intervention trials that employ smaller sample sizes than the population-based surveys used in Part I. These studies, however, usually collect more detailed information and often obtain longitudinal followup data.

## **PART I. CHANGES IN SMOKING BEHAVIOR**

### **Trends in Cigarette Smoking**

#### **Introduction**

Accurate information on trends in smoking prevalence in the major sociodemographic groups in the United States is of interest to public health officials, policymakers, researchers, clinicians, and news media. These data are important for estimating the magnitude of the problem of smoking and for targeting public health interventions to those at highest risk of smoking.

Accurate data on trends in smoking (including initiation and quitting) are necessary to be able to project future smoking patterns. Accurate projections must be available, in turn, to set appropriate but realistic goals for key future years (e.g., 1990, 2000). This Section analyzes trends in smoking prevalence, quitting, and initiation during the past quarter century. Data on smoking prevalence in the 1940s and 1950s from Gallup surveys and the Current Population Survey have been cited elsewhere (CDC 1987a; US DHHS 1988, Appendix A).

Changes in measures of smoking behavior (e.g., prevalence, quitting, initiation), like any quantitative variables, can be calculated as absolute or relative changes. For changes in percentages, the absolute change would be in percentage points; the relative (percent) change would be calculated by subtracting the “new” percentage from the base percentage, dividing the difference by the base percentage, and multiplying the quotient by 100. Each measure of change has advantages and disadvantages. Throughout Part I of this Chapter, changes in smoking prevalence, quitting, and initiation are described primarily in terms of absolute changes.

### **Nature and Quality of Data**

A number of sources of information provide insight into smoking behavior in the United States. These sources fall into two main categories: those based on excise taxation of cigarettes and those based on population surveys of self-reported smoking.

#### **Excise Tax and Sales Data**

The Economic Research Service of the U.S. Department of Agriculture (USDA) has estimated total and adult per capita consumption of cigarettes for a number of years. These estimates are based on data from the Bureau of Alcohol, Tobacco and Firearms (Department of Treasury), the Bureau of Commerce (Department of Commerce), the Tobacco Institute, and other private and industry sources.

The Tobacco Institute reports the number of packs of cigarettes on which State taxes are paid; the Bureau of Alcohol, Tobacco and Firearms reports the number of cigarettes on which Federal taxes are paid; and the Bureau of Commerce reports the number of cigarettes imported into the United States. Both Federal and State taxes are excise taxes collected at the wholesale level (on removals) and are not standard sales taxes.

The estimated level of consumption is based on both Federal and State taxes on removals, as well as on imports, and is adjusted for estimated inventory changes. Adult per capita consumption is customarily calculated in the United States by dividing total consumption by the total estimated population 18 years of age and older. (The World Health Organization (1988) has published per capita cigarette consumption figures for countries throughout the world based on the population 15 years of age and older.)

#### **Self-Reported Survey Data**

A number of different data sources are available to assess national trends in smoking during the past 25 years. These surveys differ on the basis of sample size, method of data collection (telephone interview versus face-to-face household interview versus questionnaire administered in school), population (adults versus adolescents), sampling frame (national versus State based), and the extent of information collected on tobacco use. Details of the methodology for the various surveys are provided in the Appendix to Chapter 4 and in Table 1 of that chapter. The amount of information provided varies from survey to survey depending on the availability of information.

## Validity of Self-Reported Survey Data

The validity of self-reports of smoking status from surveys may affect the usefulness of these data in reporting historical trends. Respondents' sensitivity to the social stigma associated with smoking has been cited as a reason persons might underreport their smoking status (Warner 1978; Kozlowski 1986). Whereas biochemical assessment is generally more reliable than self-report in assessing level of nicotine intake (US DHHS 1988), self-reported data appear valid for estimating prevalence of smoking in the population. For example, studies of patients in several settings (Petitti, Friedman, Kahn 1981; Pojer et al. 1984), as well as two large community studies (Fortmann et al. 1984; Pierce, Dwyer et al. 1987b), have shown that measurement of smoking by self-report or by biochemical markers gives approximately the same estimates of prevalence. A more recent study of 1,317 Hispanics, however, showed that self-reported cigarette use underestimated biochemically validated use (Coultas et al. 1988).

It is possible that the accuracy of self-reported data will vary depending on whether the data collection method is face to face or by telephone interview. Although biochemical-validation data do not exist to allow the quantification of such a difference, comparisons of smoking prevalence estimates derived from surveys using telephone versus in-person interviews have shown that the former are generally 1 to 3 percentage points below the latter (CDC 1987a; see below and NCHS 1987). In addition, concerns have been expressed about the validity of data reported by one person on behalf of another ("proxy response") (NCHS 1985, p. 54). For adults, these concerns relate more to measures of the number of cigarettes smoked per day than to the classification of whether a person is a current smoker (US DHEW 1969, p. 794; Rogot and Reid 1975; National Research Council 1986, pp. 110–112). For adolescents, proxy reporting may also affect prevalence estimates (Millar 1985).

## Correlation Between Self-Reported Survey Data and Sales Data

Warner (1978) compared self-reported data on cigarette consumption with USDA consumption data for the years 1964–75. He found that self-reported cigarette consumption increasingly underestimated the USDA estimates, possibly because of the increasing social stigma associated with smoking. Changing social acceptability of smoking would not be expected to affect the USDA estimates. To the extent that a "social acceptability" bias in self-reported data may have increased in recent years, the dramatic decrease in smoking prevalence observed during the past 25 years could be in part artifactual.

Hatziandreu et al. (in press) analyzed more recent data to determine whether the trend reported by Warner (1978) has continued. Self-reported consumption data for adults and teenagers were obtained from the National Health Interview Survey (NHIS) (National Center for Health Statistics (NCHS)) and the National Household Survey on Drug Abuse (National Institute on Drug Abuse (NIDA)). Self-reported cigarette consumption was estimated based on the smoking prevalence, the average self-reported number of cigarettes smoked per day, and the U.S. population size each year. A "consumption ratio" was calculated by dividing self-reported consumption by USDA estimates ob-

tained from cigarette tax data. This ratio has been relatively stable recently, varying from 0.73 in 1974 to 0.69 in 1976 with a mean of 0.72 (Table 1). A least-squares regression analysis was used to identify any trend. The slope of the regression line was not significantly different from zero ( $p=0.85$ ), countering the hypothesis that self-reported data are increasingly underestimating actual cigarette consumption. These results suggest that national surveys provide a reliable estimate of U.S. smoking trends. The reasons for the consistent difference between cigarette consumption based on excise tax data versus self-reported data are unclear; one possible explanation would be a systematic bias from "rounding down" of self-reported daily consumption to the nearest multiple of a half-pack (see Table 14 and related discussion and Kozlowski 1986).

**TABLE 1.—Estimates of cigarette consumption in the United States, based on cigarette excise taxes and self-reports, 1974–85**

| Year | Excise taxes<br>(billions) | Self-reported<br>(billions) | Fraction |
|------|----------------------------|-----------------------------|----------|
| 1974 | 599.0                      | 434.9                       | 0.73     |
| 1976 | 613.5                      | 424.4                       | 0.69     |
| 1978 | 616.0                      | 438.4                       | 0.71     |
| 1979 | 621.5                      | 441.2                       | 0.71     |
| 1980 | 631.5                      | 459.1                       | 0.73     |
| 1983 | 600.0                      | 467.8                       | 0.78     |
| 1985 | 594.0                      | 414.4                       | 0.70     |

NOTE: Estimated by the U.S. Department of Agriculture. Self-reported consumption includes estimated consumption for adults (NHIS, NCHS) and estimated consumption for adolescents (National Household Survey on Drug Abuse, NIDA).

SOURCE: Hatziandreu et al., in press.

The difference in the findings reported by Hatziandreu et al. (in press) and Warner (1978) may relate to differences in methodology. For example, Warner used data from the 1964, 1966, 1970, and 1975 Adult Use of Tobacco Surveys (AUTSs). He found that the major decrease in the consumption ratio occurred between 1966 and 1970. This may have occurred because the 1964 and 1966 AUTSs were in-person surveys, whereas the 1970 and 1975 AUTSs were telephone surveys. As mentioned above, telephone surveys generally provide slightly lower estimates of smoking prevalence than in-person surveys. On the other hand, Hatziandreu et al. (in press) used only in-person interview data (NHIS) for adults and the NIDA Household Interview Survey on Drug Use for adolescents. The consumption ratios obtained by Warner for 1964 and 1966 (0.73 and 0.72, respectively) using in-person survey data were similar to the mean ratio (0.72) reported by Hatziandreu et al. for the period 1974–85. In addition, the 1974 in-person estimate was 0.73 (Hatziandreu et al., in press), whereas the 1975 telephone estimate was 0.64 (Warner 1978). This difference provides further evidence that the decrease in the consumption ratio reported by Warner was an artifact of the change in the AUTS methodology.

## Trends in Cigarette Sales

Total cigarette consumption in the United States (as estimated by sales data) increased steadily from 1900 until 1981, when an estimated total of 640 billion cigarettes were smoked (Table 2). Since 1981, there has been a steady decline in consumption despite increasing population size. The number of cigarettes smoked in 1987 is estimated at 574 billion.

These figures refer to manufactured cigarettes and do not include roll-your-own cigarettes. Roll-your-own cigarettes have accounted for a declining proportion of total cigarettes consumed through the 20th century. By 1950, the estimated per capita consumption of roll-your-own cigarettes was 126, or 3.4 percent of total cigarettes consumed; in 1987, these figures were 23 and 0.7 percent, respectively (USDA, unpublished data).

Cigarette consumption data are divided by the population of adults 18 years of age and older to give an estimate of adult per capita consumption. This estimate represents the average number of cigarettes sold per adult in the population, not per smoker. It should be noted that trends in adult per capita consumption are somewhat biased because there has been a trend over time for more people to start smoking regularly under age 18 (see section below on Trends in the Initiation of Smoking).

Per capita consumption of manufactured cigarettes increased dramatically from its level of 54 cigarettes in 1900 to 4,171 cigarettes in 1960 (Table 2). From 1960–73, this figure remained relatively stable (compared with the previous rates of change) at about 4,000 cigarettes per year. Since 1973, there has been a yearly decline in per capita consumption. From 1973–87, this figure fell more than 23 percent to 3,196 cigarettes per year. Although there has been a decline in every one of these 15 years, the rate of decline has varied. From 1974–79, the magnitude of the yearly change increased rapidly until it reached a 2-percent decrease per year. In the 10 years since 1979, this decrease has fluctuated with a mean of 2.4 percent per year (standard deviation (S.D.) = 1.9). The large drop from 1982–83 (7.2 percent) was more than two standard deviations above the mean and is thought to be related, to a significant degree, to the March 1983 increase in the Federal cigarette excise tax from 8 cents per pack to 16 cents per pack (see Chapter 7).

Trends in cigarette sales are also presented in Chapter 8 (Figure 3).

## Trends in Smoking Prevalence Among Adults

Cigarette Smoking by Sex, Race (Whites and Blacks), and Educational Attainment  
(National Health Interview Surveys: 1965–87)

Table 3 presents smoking prevalence from NHIS data for the years 1965, 1966, 1970, 1974, 1976–80 inclusive, 1983, and 1985, and preliminary data for 1987. These data are presented for the total adult population (aged 20 years and older) and by sex, race (whites and blacks), and educational attainment. They differ slightly from estimates published by NCHS (NCHS 1988c) because the data presented here are adjusted to the



**TABLE 2.—Total manufactured U.S. cigarette consumption and per capita consumption, adults aged 18 years and older, 1900–87**

| Year            | Total consumption<br>(billions) | Per capita<br>consumption | Percentage change in per<br>capita consumption<br>from previous year |
|-----------------|---------------------------------|---------------------------|--|
| 1900            | 2.5                             | 54                        |  |
| 1910            | 8.6                             | 151                       | +10.8 <sup>a</sup>   |
| 1920            | 44.6                            | 665                       | +16.0 <sup>a</sup>   |
| 1930            | 119.3                           | 1,185                     | +5.9 <sup>a</sup>  |
| 1940            | 181.9                           | 1,976                     | +5.2 <sup>a</sup>  |
| 1950            | 369.8                           | 3,552                     | +6.0 <sup>a</sup>  |
| 1960            | 484.4                           | 4,171                     | +1.6 <sup>a</sup>  |
| 1961            | 502.5                           | 4,266                     | +2.3   |
| 1962            | 508.4                           | 4,266                     | 0  |
| 1963            | 523.9                           | 4,345                     | +1.9   |
| 1964            | 511.3                           | 4,194                     | -3.5   |
| 1965            | 528.8                           | 4,258                     | +1.5   |
| 1966            | 541.3                           | 4,287                     | +0.7   |
| 1967            | 549.3                           | 4,280                     | -0.2   |
| 1968            | 545.6                           | 4,186                     | -2.2   |
| 1969            | 528.0                           | 3,993                     | -4.6   |
| 1970            | 536.5                           | 3,985                     | -0.2   |
| 1971            | 555.2                           | 4,037                     | +1.3   |
| 1972            | 566.8                           | 4,043                     | +0.1   |
| 1973            | 589.7                           | 4,148                     | +3.0   |
| 1974            | 599.0                           | 4,141                     | -0.2   |
| 1975            | 607.2                           | 4,123                     | -0.4   |
| 1976            | 613.5                           | 4,092                     | -0.8   |
| 1977            | 617.0                           | 4,051                     | -1.0   |
| 1978            | 616.0                           | 3,967                     | -2.1   |
| 1979            | 621.5                           | 3,861                     | -2.7   |
| 1980            | 631.5                           | 3,844                     | -0.4   |
| 1981            | 640.0                           | 3,836                     | -0.2   |
| 1982            | 634.0                           | 3,739                     | -2.6   |
| 1983            | 600.0                           | 3,488                     | -7.2   |
| 1984            | 600.4                           | 3,446                     | -1.2   |
| 1985            | 594.0                           | 3,370                     | -2.3   |
| 1986            | 583.8                           | 3,274                     | -2.9   |
| 1987 (estimate) | 574.0                           | 3,196                     | -2.4   |

<sup>a</sup>Annualized rate of change during preceding decade.

SOURCE: USDA (1987).

**TABLE 3.—Trends in smoking prevalence (%), NHISs, United States, 1965–87, adults aged 20 years and older**

| Year                               | Overall population | Sex   |         | Race   |        | Educational level              |                      |              |                  |
|------------------------------------|--------------------|-------|---------|--------|--------|--------------------------------|----------------------|--------------|------------------|
|                                    |                    | Males | Females | Whites | Blacks | Less than high school graduate | High school graduate | Some college | College graduate |
| 1965 <sup>a</sup>                  | 40.4               | 50.2  | 31.9    | 40.0   | 43.0   |                                |                      |              |                  |
| 1966                               | 40.7               | 50.8  | 32.0    | 40.4   | 42.9   | 36.5                           | 41.1                 | 42.5         | 33.7             |
| 1970                               | 37.0               | 44.3  | 30.8    | 36.5   | 41.4   | 34.8                           | 38.3                 | 36.7         | 28.1             |
| 1974                               | 36.9               | 43.4  | 31.4    | 36.1   | 44.0   | 36.5                           | 37.6                 | 36.9         | 28.3             |
| 1976                               | 36.1               | 42.1  | 31.3    | 35.6   | 41.2   | 35.8                           | 37.8                 | 36.4         | 27.4             |
| 1977                               | 35.6               | 40.9  | 31.4    | 34.9   | 41.8   | 35.8                           | 38.4                 | 35.2         | 25.6             |
| 1978                               | 34.0               | 39.0  | 29.6    | 33.6   | 38.2   | 35.3                           | 36.5                 | 32.7         | 23.8             |
| 1979                               | 33.5               | 38.4  | 29.2    | 33.2   | 36.8   | 34.9                           | 35.4                 | 33.3         | 23.4             |
| 1980                               | 33.3               | 38.5  | 29.0    | 32.9   | 37.2   | 35.5                           | 35.7                 | 31.2         | 24.6             |
| 1983                               | 31.8               | 35.5  | 28.7    | 31.4   | 36.6   | 34.7                           | 35.6                 | 30.0         | 19.9             |
| 1985                               | 30.4               | 33.2  | 28.0    | 29.9   | 36.0   | 35.7                           | 34.2                 | 28.1         | 18.4             |
| 1987 <sup>b</sup>                  | 29.1               | 31.7  | 26.8    | 28.8   | 34.0   | 35.7                           | 33.1                 | 26.1         | 16.3             |
| <b>Trend information (1965–85)</b> |                    |       |         |        |        |                                |                      |              |                  |
| Change <sup>c</sup> /year          | –0.50              | –0.84 | –0.21   | –0.50  | –0.39  | –0.06                          | –0.32                | –0.70        | –0.76            |
| Standard error                     | 0.03               | 0.04  | 0.03    | 0.03   | 0.08   | 0.03                           | 0.05                 | 0.07         | 0.08             |
| R <sup>2</sup>                     | 0.97               | 0.98  | 0.81    | 0.97   | 0.74   | NA <sup>d</sup>                | 0.87                 | 0.94         | 0.93             |

<sup>a</sup>For 1965, data stratified by education were not available.

<sup>b</sup>Provisional data only.

<sup>c</sup>In percentage points.

<sup>d</sup>The slope of the regression line was not significantly different from zero, making the R<sup>2</sup> computation inappropriate.

SOURCE: NHISs 1965–87; unpublished data. Office on Smoking and Health.

1985 age distribution, whereas the previously published figures were adjusted to the 1970 age distribution.

For each group, observed smoking prevalence for each survey year is reported. Additionally, to assess time trends from 1965–85, weighted least-squares regression analyses have been applied to these data. The 1987 data were not included in the regression analyses because these data are preliminary estimates. These estimates can be used to provide a measure of predictive validity of the model; in general, the preliminary 1987 estimates are similar to projections from the model (Pierce, Fiore et al. 1989a).

The  $R^2$  statistic was used for each trend analysis and is a measure of how well the linear model fits the observed data values.  $R^2$  values may range from 0 (no linear trend) to 1.0 (a perfect fit between the observed values and a linear model).

The data on overall smoking prevalence, as well as for each sex and racial group presented in Table 3, demonstrate linear trends with  $R^2$  values ranging from 0.74 to 0.98; thus, the models fit the data very well. Trends for three of the four educational categories are also fitted well by a linear model. For one category, less than high school graduation, no  $R^2$  value is reported because the rate of change is very close to zero (making the  $R^2$  statistic inappropriate as an index of the amount of variation explained by the model). The change (in percentage points) per year is the slope of the line of best fit calculated by the model. The standard error of the slope allows confidence limits to be placed around the estimate of change per year. Ninety-five-percent confidence limits around the estimate of a slope are approximately equal to the slope plus or minus two times the standard error.

Overall smoking prevalence declined from 40.4 percent in 1965 to 29.1 percent in 1987. The trend from 1965–85 is fitted almost exactly by a linear model ( $R^2=0.97$ ). Smoking prevalence in the United States adult population is decreasing at a rate of 0.50 percentage points per year with a standard error of 0.03. Thus, the 95-percent confidence interval for the change per year is 0.44 to 0.56. There is no evidence of any sudden deviations from the identified trend such as that seen in the per capita consumption data in 1983 (Table 2).

The prevalence of smoking among men has decreased steadily from 50.2 percent in 1965 to 31.7 percent in 1987. The rate of decline between 1965 and 1985 was 0.84 percentage points per year (95-percent confidence limits, 0.76, 0.92). Female smoking prevalence remained stable at 31 to 32 percent from 1965–77. Subsequently, prevalence began to decline slowly and reached 26.8 percent in 1987. The overall rate of decline from 1965–85 was 0.21 percentage points per year (95-percent confidence limits, 0.15, 0.27). Fiore and coworkers (1989) have examined more recent trends in smoking by gender in greater detail. This analysis showed a rate of decline in prevalence among women of 0.33 percentage points per year between 1974 and 1985 (95-percent confidence limits, 0.21, 0.45) ( $R^2=0.88$ ).

Although there has been a difference in smoking prevalence between blacks and whites, it may be explained by socioeconomic status (Novotny, Warner et al. 1988), and the rate of change in smoking prevalence in recent years has been similar between the races (Fiore et al. 1989). Smoking among whites decreased from 40.0 percent in 1965 to 28.8 percent in 1987. The rate of decline from 1965–85 was 0.50 percentage points per year (95-percent confidence limits, 0.44, 0.56;  $R^2=0.97$ ).

For blacks the  $R^2$  value for the simple linear model is 0.74, suggesting that the data should be reviewed more carefully. In 1965, 43.0 percent of blacks smoked. This number had changed little by 1977 when 41.8 percent smoked. From 1977–87, there was a considerable drop in smoking prevalence to 34.0 percent. Thus, the data suggest that there may be two trends among blacks. Fiore et al. (1989) fitted a linear model to the data for 1974–85 and reported a rate of change among blacks of  $-0.67$  percentage points per year with 95-percent confidence limits of 0.37 and 0.97 ( $R^2=0.80$ ). This rate of change was not significantly higher than that among whites for the same period ( $-0.57$  percentage points per year). However, smoking prevalence among black men was decreasing at a faster rate than among white men (1.15 percentage points per year compared with 0.87,  $p=0.03$ ). There were no significant differences noted in the rates of decrease among women of either race (blacks, 0.26 percentage points per year; whites, 0.32).

Trends in smoking among the various educational groups have differed markedly since 1966 (Pierce, Fiore et al. 1989b). College graduates have decreased their smoking level from 33.7 percent in 1966 to 16.3 percent in 1987. The rate of decline from 1966–85 was 0.76 percentage points per year (95-percent confidence limits, 0.60 to 0.92). Smoking prevalence in respondents who reported having attended some college decreased from 42.5 percent in 1966 to 26.1 percent in 1987 at a slightly lower rate of change ( $-0.70$  percentage points per year) than that of college graduates. High school graduates who did not attend college reduced their smoking from 41.1 percent in 1966 to 33.1 percent in 1987 at a rate ( $-0.32$  percentage points per year) less than half that for respondents who had attended college. Smoking prevalence in those respondents without a high school diploma did not change appreciably from 1966 (36.5 percent) to 1987 (35.7 percent); the rate of decline between 1966 and 1985 was only 0.06 percentage points per year. Thus, there is a twelvefold difference in rate of decline in smoking prevalence between the most and least educated groups in our society. The increasing gap in smoking prevalence by educational attainment is particularly evident when comparing the difference in smoking prevalence between the most and least educated groups in 1966 with the difference in 1987. In 1966, the prevalence rates were similar (33.7 and 36.5 percent, respectively); in 1987, prevalence in the most educated group (16.3 percent) was less than half that in the least educated group (35.7 percent).

#### Adult Use of Tobacco Surveys: 1964–86

In 1964, 1966, 1970, 1975, and 1986, the Office on Smoking and Health (formerly the National Clearinghouse for Smoking and Health) conducted detailed surveys of a representative sample of the U.S. adult population. The purpose of these surveys has been to study the population's knowledge, attitudes, and practices regarding the use of tobacco. The first two surveys primarily used in-person household interviews while the last three used telephone interviews. Prevalence of cigarette smoking in the United States as measured by the AUTSs has declined from 40.3 percent in 1964 to 26.5 percent in 1986 (Table 4). This decrease represents an overall decline in smoking of more than 34 percent during this 22-year period.

**TABLE 4.—Trends in smoking prevalence (%), AUTS versus NHIS**

| Survey year | AUTS <sup>a</sup> | Estimated NHIS <sup>b</sup> | Difference (NHIS–AUTS) |
|-------------|-------------------|-----------------------------|------------------------|
| 1964        | 40.3              | 40.4                        | 0.1                    |
| 1966        | 42.2              | 39.4                        | –2.8                   |
| 1970        | 36.2              | 37.4                        | 1.2                    |
| 1975        | 33.8              | 34.9                        | 1.1                    |
| 1986        | 26.5              | 29.4                        | 2.9                    |

<sup>a</sup>For all survey years, includes respondents aged 21 years and older except 1986, which includes respondents aged 17 years and older. All data weighted.

<sup>b</sup>Includes respondents aged 20 years and older. Values for each year are determined by extrapolating expected prevalence values based on regression analysis from Table 3.

SOURCE: Office on Smoking and Health (US DHEW 1969, 1973a, 1976; CDC 1987a).

Unlike the NHIS, for which data are collected during an in-person household interview, AUTSs collected data via telephone interviews in 1970, 1975, and 1986. The three AUTSs conducted since 1970 all produced prevalence estimates below those estimated (by regression analysis) from the NHISs (Table 4). The largest difference between the two surveys was 2.9 percentage points in 1986. The 95-percent confidence limits around the NHIS projection for 1986 are 27.8 to 31.7 compared with limits of 25.8 to 27.3 from the 1986 AUTS; thus, the difference in estimates between the two surveys is statistically significant. A difference in sampling modalities is among the most likely explanations for this discrepancy in prevalence estimates. A similar finding has been noted in State-specific prevalence estimates (see below). Telephone surveys have a small sampling bias by excluding households lacking telephones and may have a greater nonresponse bias because of generally lower response rates compared with household surveys (CDC 1987a).

#### Cigarette Smoking Among Different Occupational Groups

NHIS data have been published on smoking prevalence by occupation for the years 1970, 1978–80 combined, and 1985 (Table 5). There is a consistent pattern of higher smoking rates among blue-collar and service workers than among white-collar workers for all these survey years. For example, in 1985, the prevalence of smoking among blue-collar and white-collar workers was 40 and 28 percent, respectively. This difference was greater among males (14 percentage points) than among females (6 percentage points). Detailed data on smoking prevalence, percentage of former smokers, quitting attempts, and age of initiation within specific occupational categories for 1978–80 were published in the 1985 Surgeon General's Report (US DHHS 1985). Weinkam and Sterling (1987) also provided a detailed analysis of smoking by occupation using the 1970 and 1979–80 NHIS data.

Novotny, Warner, and colleagues (1988) performed multivariate logistic regression analyses on data from the 1985 NHIS (ages 25 to 64 years) to examine the independent

**TABLE 5.—Prevalence of smoking (%) by occupation, 1970, 1978–80, and 1985**

| Occupation                | 1970 <sup>a</sup> |         | 1978–80 <sup>a</sup> |         | 1985 <sup>b</sup> |         |       |
|---------------------------|-------------------|---------|----------------------|---------|-------------------|---------|-------|
|                           | Males             | Females | Males                | Females | Males             | Females | Total |
| <b>Currently employed</b> | 47.9              | 36.5    | 39.9                 | 33.3    | 33.8              | 30.0    | 32.1  |
| White collar              | 40.8              | 36.1    | 33.0                 | 31.9    | 26.4              | 28.0    | 27.5  |
| Blue collar               | 55.0              | 37.7    | 47.1                 | 38.1    | 40.1              | 33.9    | 39.7  |
| Service                   | 53.3              | 39.4    | 47.5                 | 37.4    | 40.3              | 35.4    | 37.2  |
| <b>Unemployed</b>         | 55.9              | 42.3    | 53.1                 | 39.6    | 44.3              | 28.0    | 36.1  |

<sup>a</sup> Aged 20 to 64 years.

<sup>b</sup> Aged 20 years and older.

SOURCE: NHISs 1970, 1978–80 (combined), and 1985, NCHS (US DHHS 1985, 1988).

effects of socioeconomic status (SES) and selected demographic factors on the odds of ever smoking (versus never smoking) and current smoking (versus former smoking). The SES/demographic factors included in the models were: sex, employment status, occupation, education, marital status, and poverty status. The investigators found that when they simultaneously controlled for the effects of these factors, unemployed persons were more likely than employed persons to be ever smokers or current smokers. However, blue-collar and service workers were not found to have significantly increased odds of ever or current smoking compared with white-collar workers. Employed persons were more likely to have quit smoking than unemployed persons.

#### Special Populations: Hispanics

Information on smoking among Hispanics was collected as part of the Hispanic Health and Nutrition Examination Survey (HHANES) between 1982 and 1984. This was a geographically based sample of Hispanics from three areas of the United States designed to represent three large Hispanic groups (Puerto Ricans in the New York City area; Cuban-Americans in Dade County, Florida; and Mexican-Americans in the Southwest). Sample sizes were 9,000 Mexican-Americans, 4,000 Puerto Ricans, and 1,500 Cuban-Americans.

According to the HHANES, the age-adjusted smoking rates for males aged 20 to 74 years were 43 percent for Mexican-Americans, 42 percent for Cuban-Americans, and 40 percent for Puerto Ricans. Among females, the smoking prevalence was 24 percent for Mexican-Americans and Cuban Americans and 30 percent for Puerto Rican Americans (Haynes 1987). A birth-cohort analysis of these data showed that smoking rates have decreased among successive cohorts of men, but increased among successive cohorts of women (Escobedo and Remington 1989).

These rates are higher than those obtained from the NHISs for the years 1979 and 1980 (Marcus and Crane 1985; Rogers and Crank 1988) and 1985 (Marcus and Crane 1987). However, the number of Hispanics in these NHIS samples was small, making prevalence estimates less reliable. Haynes (1987) suggests that NHIS data may underestimate smoking prevalence among Hispanics because questions about smoking were not asked in Spanish. The first estimates of smoking behavior among Hispanics that are both national and statistically reliable will be available from the 1987 NHIS, which oversampled for this population group.

#### Special Populations: American Indians and Alaskan Natives

There are no reliable national estimates of smoking prevalence among American Indians. Several surveys have assessed smoking rates among specific Indian tribes or on certain Indian reservations (CDC 1987b). Smoking prevalence is highest among Northern Plains Indians (42 to 70 percent) and Alaskan Natives (56 percent), where rates greatly exceed the rate in the general U.S. population. Much lower rates have been reported for Indians from the Southwest (13 to 28 percent). High rates of smokeless tobacco use have also been reported among some American Indian groups, especially in Indian youth. According to a survey of approximately 5,000 children 5 to 18 years of age in rural Alaska conducted by the Indian Health Service, 28 percent of girls and 34 percent of boys reported using smokeless tobacco products (CDC 1987c). Similar findings were obtained in other surveys of Native Americans (Schinke et al. 1987; CDC 1988; Hall and Dexter 1988).

### Special Populations: Asian Americans

There are no reliable national estimates of smoking prevalence among Asian Americans. A few local surveys provide estimates of smoking prevalence among Asian Americans in specific geographic regions.

The State of Hawaii has a population composed of 29 percent Caucasian, 26 percent Japanese, 15 percent Hawaiian, and 15 percent Filipino. The State conducted a Behavioral Risk Factor Survey (see below) of 1,002 people by telephone in 1984. Smoking prevalence estimates were 28 percent for Caucasians, 27 percent for both Hawaiians and Filipinos, and 23 percent for Japanese (Hawaii State Department of Health 1984). A similar survey of 1,557 residents of the State was completed in 1986. Prevalence estimates from this second survey were 29.3 percent for Caucasians, 28.8 percent for Hawaiians, 25.1 percent for Filipinos, and 20.6 percent for Japanese (Chung 1986).

### Special Populations: Pregnant Women

National data on smoking during pregnancy are scarce, especially prior to 1980. Since 1980, several national surveys have directed smoking questions to previously pregnant women, but survey methodologies vary widely and it is not possible to study secular changes in behavior.

Probably the best source of national data on smoking among pregnant women has been the National Natality Surveys (NNSs), which were conducted among national samples of married mothers of live infants born in 1967 and 1980. Data from these surveys were used by Kleinman and Kopstein (1987) to document changes in smoking behavior during pregnancy over that period of time. Among teenagers, smoking rates remained fairly constant over time at about 38 percent among whites and 27 percent among blacks. Among women over age 20, there were decreases in smoking prevalence that varied markedly by race and by educational attainment of the mother. Smoking prevalence among white women over age 20 declined from 40 percent in 1967 to 25 percent in 1980; among black women over age 20, it declined from 33 percent to 23 percent. Among white women over age 20, there was an increase in the proportion quitting smoking during pregnancy (11 percent to 16 percent), while among blacks the proportion quitting actually decreased (17 percent to 11 percent). Among white women with less than 12 years of education, the prevalence of smoking during pregnancy declined from 48 percent to 43 percent, while for women with 16 or more years of education, it declined from 34 percent to 11 percent. Among white smokers with less than 12 years of education, there was relatively little change in the proportion quitting during pregnancy (11 percent to 9 percent), but among smokers with 16 years or more of education, the proportion more than doubled (12 percent to 27 percent). Insufficient numbers of black women were sampled to study trends by education among blacks.

A study similar to the NNS, the National Maternal and Infant Health Survey, was begun in 1988. Data from that study will provide the best estimates of smoking during pregnancy for the late 1980s. At this time, however, no comparable national data exist to study women after 1980. Studies that have asked about smoking behavior during pregnancy have not asked about behavior during specific years, so it is not possible to